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Creature Feature: An Intuitive System for Designing 3D Models

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Abstract

Creating 3D computer models is a difficult, time consuming task. Existing systems capable of providing detailed, expressive models of sufficient quality for "Hollywood" or CAD are complex, labor-intensive, and have a steep learning curve, thus limiting creativity and the availability of good 3D models. While there have been recent advances in intuitive design methods for 3D modeling (e.g. [Igarashi et al. 1999]), such systems produce soft, blobby models of insufficient quality for these applications.

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Introduction

Creating 3D computer models is a difficult, time consuming task. Existing systems capable of providing detailed, expressive models of sufficient quality for "Hollywood" or CAD are complex, labor-intensive, and have a steep learning curve, thus limiting creativity and the availability of good 3D models. While there have been recent advances in intuitive design methods for 3D modeling (e.g., [Igarashi et al. 1999]), such systems produce soft, blobby models of insufficient quality for these applications.

In this sketch, we present Creature Feature, a system for creating expressive and detailed 3D creatures and other organic models via a simple and intuitive interaction method. Mimicking traditional 2D drawing, this system provides a means for 1) free-hand sketching of 3D skeletal curves, 2) fleshing out a basic shape of the object, and 3) final detailed editing and geometric texturing. Leveraging off the principle of feature-based design in CAD, Creature Feature allows *features* (e.g., the shape of a skeletal curve) created at various stages in the design process to be modified at any time, automatically propagating the change to the final model.

This work builds on a vast body of prior art including implicit modeling (e.g., [Bloomenthal 1997] and [Bloomenthal and Wyvill 1990]), modeling with generalized cylinders (e.g., [Crespin et al. 1996] and [Aguado et al. 1999]), and sketched-based input, particularly 3D curve sketching ([Cohen et al. 2001] and [Grimm 1999]).

System Description

Creature Feature contains three fundamental stages. In the first stage, the user sketches a skeleton composed of 3D curves using the method of [Cohen et al. 2001]. Skeletal curves can be added, deleted, and modified at any time during the design process. Future work includes adding kinematic joints so that the skeleton can be easily articulated for posing the model and key framing.

In the second stage, the user fleshes out the basic shape by creating a set of 2D cross sections along the skeletal curves and lofting between these cross sections using a new lofting algorithm based on distance fields. Creature Feature uses adaptively sampled distance fields (ADFs) [Frisken et al. 2000] to represent the 3D model, providing 1) an implicit representation that permits robust lofting between cross sections of arbitrary topology and 2) the ability to represent and process detailed geometry efficiently.

The cross sections (represented as 2D ADFs) can be created and modified via a new 2D editor that provides a seamless interface between pixel-based (painting) and vector-based (curve drawing) metaphors. Because lofting is performed as an implicit blend, the cross sections can have arbitrary topology.

The 2D cross sections are placed perpendicular to skeletal curves at oriented anchor points along the curves. Anchor points can be added, deleted, rotated, and moved along curves by the user to define important cross sections of the object. As the cursor is moved along a skeletal curve, the current blended cross section is displayed in the 2D editor. Clicking on the skeletal curve creates a new anchor point on the curve and a corresponding cross section initialized to the blended cross section that can then be modified with the 2D editor. This functionality provides an effective and natural process for refining the basic shape.

At any point during the first two stages, an ADF model of the basic shape can be generated in a few seconds by lofting between cross sections along the curve, providing a fast design review cycle. The ADF model can be viewed interactively via adaptive ray casting or converted to triangles (in a fraction of a second) for conventional polygon rendering [Perry and Frisken 2001].

During the final stage of the design process, a high-resolution ADF model is generated and intricate detail and geometric texture is applied via a brush-based metaphor. Creature Feature is built on top of Kizamu [Perry and Frisken 2001], an ADF-based sculpting system that has been augmented to include pressure-sensitive pen-based input and a new memory management system that provides both significant performance improvements and infinite undo/redo capability. Currently, the final stage is decoupled from the first two stages, violating our goal of feature-based design. Future work includes parameterizing the sculpted detail based on the skeletal curves to address this issue.

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Left: Skeletal curves and cross sections for a 3D creature. Middle: The basic shape generated using a robust new ADF-based lofting method. Right: The model with intricate detail and geometric texture added.